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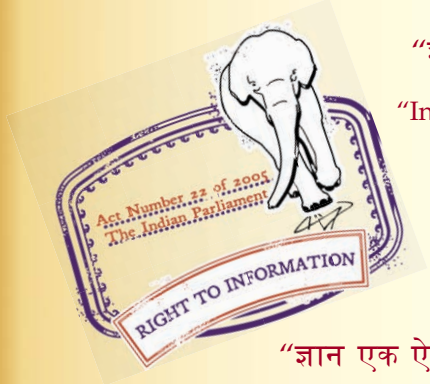
IS 10853-1 (1984): Methods of measurement for radio transmitters, Part 1: General conditions of measurement [LITD 12: Transmitting Equipment for Radio Communication]



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Indian Standard

METHODS OF MEASUREMENT FOR RADIO TRANSMITTERS

PART 1 GENERAL CONDITIONS OF MEASUREMENTS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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June 1984

Indian Standard

METHODS OF MEASUREMENT FOR RADIO TRANSMITTERS

PART 1 GENERAL CONDITIONS OF MEASUREMENTS

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(*Continued on page* 15)

Indian Standard

METHODS OF MEASUREMENT FOR RADIO TRANSMITTERS

PART 1 GENERAL CONDITIONS OF MEASUREMENTS

0. FOREWORD

0.1 This Indian Standard (Part 1) was adopted by the Indian Standards Institution on 16 January 1984, after the draft finalized by the Radio Communications Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The object of this standard is to standardize the conditions and methods of measurements to be used to ascertain the performance of a radio transmitter and to make possible the comparison of the results of measurements made by different observers.

0.3 This standard is one of a series of standards on methods of measurements for assessing the performance of radio transmitters for various classes of emission and covers general conditions of measurements. Other characteristics likely to be covered in this series are:

a) Frequency;

b) Output power and power consumption;

c) Band-width, out of band power;

d) Power of non-essential oscillation;

e) Wanted and unwanted modulation;

f) Amplitude/frequency characteristics aud non-linearity distortion in transmitters for radio-telephony and sound broadcasting;

g) Measurements particular to transmitters and transpowers for monochrome and colour television;

h) Cabinet radiation at frequencies between 130 kHz and 1 GHz;

j) Cabinet radiation at frequencies above 1 GHz;

k) Vestigial sideband demodulators for use in conjunction with transmitters or transposers for monochrome or colour television; and

m) Transposers for monochrome and colour television.

0.4 This standard is largely based on IEC Pub 244-1 (1968), 'Methods of measurement for radio transmitters: Part 1 General conditions of measurement, frequency, output power and power consumption, issued by the International Electrotechnical Commission (IEC).

0.5 In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard (Part 1) lays down the general conditions of measurements of characteristics, applicable to radio transmitters for all classes of emission.

2. TERMINOLOGY

2.1 For the purpose of this standard the following definitions in addition to those given to IS : 1885 (Part 22)-1967† shall apply.

2.2 Radio Transmitter — Apparatus producing radio-frequency energy for the purpose of radio-communication.

For the purpose of this standard, such auxiliary equipment as is necessary to maintain the transmitter in normal operation, together with any device to mach the impedance of the aerial (or the aerial transmission line) to the transmitter, including harmonic or other filters, shall be considered as a part of the transmitter.

2.3 Radio Transmitting System — Apparatus comprising a radio transmitter connected to its aerial or aerials; also several transmitters connected to a common aerial.

2.4 Terms Relating to Frequency Measurement (*see* Fig. 1)

2.4.1 *Assigned Frequency* — The centre of the frequency band assigned to a station.

2.4.2 *Characteristic Frequency* — A frequency which may be easily identified and measured in a given emission.

The term 'characteristic frequency' is used in this standard to denote the actual frequency of that component of the emission, the nominal value of which is the 'reference frequency'.

*Rules for rounding off numerical values (*revised*).

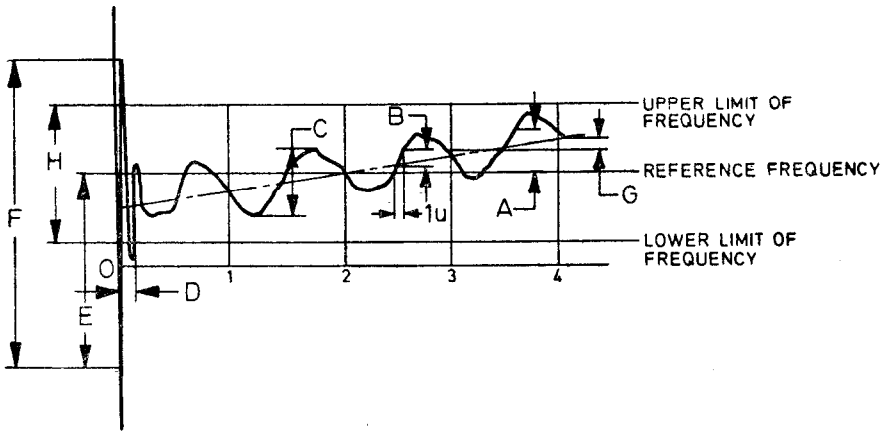
†Electrotechnical vocabulary: Part 22 Equipments for radiocommunications, transmitting and receiving.

2.4.3 *Reference Frequency* — A frequency having a fixed and specified position with respect to the assigned frequency. The displacement of this frequency with respect to the assigned frequency has the same absolute value and sign that the displacement of the characteristic frequency has with respect to the centre of the frequency band occupied by the emission.

NOTE — For certain classes of emission in which no signal is emitted in the absence of modulation, the value of the reference frequency may be deduced from the application of a sinusoidal modulating oscillation of known frequency.

2.4.4 *Frequency Variation* — The difference between the highest and the lowest value of the characteristic frequency during a specified period.

2.4.5 *Frequency Error* — The difference between the characteristic frequency at any given time and the reference frequency.



Abscissa: time in days.
Ordinate: characteristic frequency.

Example of curve showing characteristic frequency as a function of time

A = frequency error at a given instant of time,
B = frequency variation over a period of 1 h,
C = frequency variation over a period of one day,
D = initial period of frequency variation,
E = initial frequency error,
F = initial frequency variation,
G = frequency drift per day due to ageing, and
H = twice frequency tolerance.

FIG. 1 DEFINITIONS ON FREQUENCY

2.4.6 *Frequency Tolerance* — The maximum permissible departure by the centre frequency of the frequency band occupied by an emission from the assigned frequency, or by the characteristic frequency of an emission from the reference frequency. The frequency tolerance is expressed in parts per 10^6 or in cycles per second.

2.4.7 *Assigned Frequency Band* — The frequency band the centre of which coincides with the frequency assigned to the station and the width of which equals the necessary bandwidth plus twice the absolute value of the frequency tolerance.

2.4.8 *Initial Period of Frequency Variation* — The time that elapses after initial switching-on necessary to attain those conditions, in which the characteristic frequency remains within the specified tolerances, the transmitter being operated under specified conditions of operation.

2.4.9 *Initial Frequency Variation* — The frequency variation under specified operating conditions during the initial period of frequency variation.

2.4.10 *Initial Frequency Error* — The maximum value of the frequency error under specified operating conditions during the initial period of frequency variation.

2.4.11 *Maximum Frequency Error* — This is the difference between the reference frequency and the extreme value of the characteristic frequency under the most unfavourable combination of operating conditions, within the limits quoted in the relevant equipment specification with respect to primary power supply conditions, environmental conditions and conditions inherent in the normal use of the equipment.

2.4.12 *Maximum Frequency Variation* — This is the difference between the extreme values of the characteristic frequency under the most unfavourable combination of operating conditions, within the limits of the variations quoted in the relevant equipment specification for a specified period, with respect to primary power supply conditions, environmental conditions and conditions inherent in the normal use of the equipment.

2.4.13 *Frequency Drift* — This is the variation of frequency in time independent of any other parameter.

2.4.14 *Mean Frequency Setting Error* — The difference between the reference frequency and the arithmetic mean of the characteristic frequencies obtained after a specified number of rapidly repeated resetting procedures under specified operating conditions.

2.4.15 *Frequency Resetting Accuracy* — The departure, expressed as a standard deviation, of the characteristic frequency from the arithmetic mean of the characteristic frequencies obtained after a specified number

of rapidly repeated resetting procedures under specified operating conditions.

2.5 Terms Relating to Output Power Measurements

2.5.1 *Mean Power* — This is the power supplied to a test load under specified conditions of modulation, averaged over a time sufficiently long compared with the period of the lowest frequency encountered in the modulation.

2.5.2 *Carrier Power* — This is the average power supplied to a test load during one rf cycle under conditions of no modulation: for each class of emission the condition of no modulation shall be specified.

2.5.3 *Peak Envelope Power* — This is the average power supplied to a test load during one rf cycle at the highest crest of the modulation envelope taken under specified conditions of modulation.

2.5.4 *Rated Power* — This is the power nominally available at the output terminal device connected to a load, both a specified by the manufacturer, at the end of a specified starting period and under specified environmental conditions and specified conditions of primary power supply and modulation.

2.6 Power Consumption of a Radio Transmitter — This is the power delivered to the apparatus under specified conditions of operation and modulation, including the power absorbed by the ancillary equipment required for normal operation.

2.7 Total Power Factor — This is the ratio of the input active power to the input apparent power, both taken under the same specified conditions of operation.

2.8 Overall Efficiency — This is the ratio of the mean power delivered to a test load to the total input active power, both taken under the same specified conditions of operation.

3. CONDITIONS OF MEASUREMENT

3.1 General Conditions — Care shall be taken to avoid all conditions which may lead to damage of the transmitter, especially its tubes or valves or semiconductor devices.

3.1.1 If no other average data have been specified by the transmitter manufacturer, the actual characteristics of each tube or valve or semiconductor device used in the transmitter during the test shall lay within its normal average data range quoted by the tube, valve or semiconductor device manufacturer.

3.1.2 Unless otherwise specified, the measurements shall be carried out under standard conditions with respect to primary power supply temperature, air pressure, humidity and terminal load, and under specified conditions of modulations, as laid down in the **3.2** and **3.3** respectively. After the radio transmitter has been finally set up for these conditions, the settings shall be kept constant during all measurements, with the exception of those settings that have to be varied before or during a specified period of the measurements.

3.2 Standard Conditions of Operation

3.2.1 *Conditions for Primary Power Supply* — The measurements are carried out at the nominal voltage and the nominal frequency of the power supply given in the relevant equipment specification.

During a series of measurements carried out as part of one test on one equipment, the voltage and the frequency of the power supply shall not deviate from the nominal values more than indicated in the relevant equipment specification.

NOTE — If a voltage regulator is incorporated in the radio transmitter being tested, and if the transmitter performance is essentially dependent upon the proper function of this regulator, the results may be quite different depending upon whether the voltage fluctuates at a fast or at a slow rate. A voltage regulator of electromechanical type shall not be able to compensate for fast voltage fluctuations and the latter may considerably affect the performance of the transmitter, unless they are taken care of in the rectifier and stabilizing circuits.

When the nominal voltage and frequency may not be obtained during the measurements, the following shall apply:

a) If the quantities to be measured depend on voltage and/or frequency and the law of dependence is known, the values are measured at a voltage and a frequency which shall be within the limits laid down in the relevant equipment specification. If necessary, the measured quantities are corrected to the nominal voltage and/or frequency by calculation.

NOTE — Attention is drawn to the fact that, in the equipment specification, different limits or the voltage and the frequency be given for different specified characteristics of the transmitter.

b) If the quantities to be measured depend on voltage and/or frequency and the law of dependence is unknown, the values are measured at a voltage and a frequency which shall lay within ± 2 percent of the nominal voltage and within ± 1 percent of the nominal frequency, unless closer tolerances are specified in the equipment specification.

Standard conditions imply the presence of the supplementary conditions for the primary power supply specified in **3.4**.

3.2.2 *Environmental Conditions* — As to the atmospheric conditions, the measurements are carried out under the 'standard environmental testing conditions' or 'standard environmental referee conditions' specified in the **3.5.1** and **3.5.2.**

3.2.3 *Terminal Load* — The transmitter shall be terminated by a test load. The characteristics of this test load with respect to power handling capacity and impedance in the relevant frequency range shall be in accordance with the quantities and tolerances given in the relevant equipment specification.

The apparatus connecting the test load to the output terminal device of the transmitter are part of the test load.

NOTE 1 — If a fluid-cooled test load is used, the coolant at its normal rate of flow shall be present when the impedance is measured.

NOTE 2 — The impedance of the test load may change depending on the power dissipated. Incandescent lamps are therefore not recommended as a test load for carrying out measurements according to this standard, particularly when amplitude modulation is present.

Investigation into the deviation from the rated data of the transmitter within the limits of the load impedance given in the relevant equipment specification is subject to agreement.

3.3 Conditions of Modulation — The measurements are carried out under conditions of modulation relevant to the class of emission specified in the relevant equipment specification, including, where applicable the condition of no modulation.

If particular measurements require the condition of modulation to be standardized, this condition is given in the clauses relevant to such measurements.

3.4 Supplementary Conditions for Primary Power Supply — In addition to conforming to the relevant sections of the equipment specification, the primary power supply used for testing a radio transmitter shall be sufficiently stable so that no appreciable variations in the performance of the transmitter under test shall be introduced by changes in the parameters of the power supply.

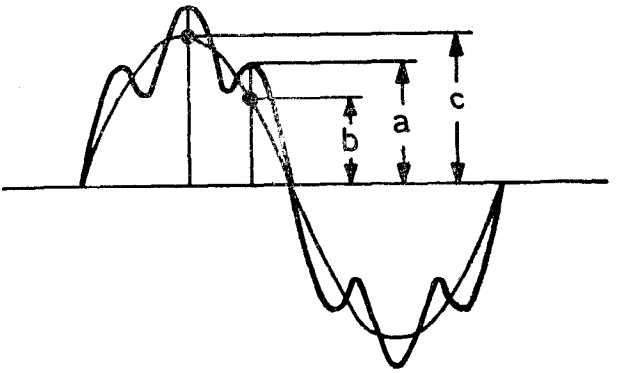
NOTE — A power supply system simultaneously supplying another load of the same nature and of the same magnitude or of a magnitude superior higher than the one presented by the transmitter and which may have influence on the transmitter performance is a special case which is not covered in this standard. This case may be covered by special arrangement, using compensating and/or protecting devices.

In general, the afore-mentioned condition will be met if the power supply conforms to the following stipulations.

3.4.1 *C. System Conditions*

3.4.1.1 *Wave-form aud source impedance* — Unless otherwise specified a substantially sinusoidal alternating, voltage source of sufficiently low impedance to have negligible influence on the operation of the transmitter, shall be connected to the ac terminals of the transmitter.

The wave-form of a voltage is considered to be substantially sinusoidal if the largest deviation from the instantaneous value of the fundamental wave for any part of the curve does not exceed 5 percent of the amplitude of the fundamental wave ($a - b \leqslant 0{\cdot}05\ c$; *see* Fig. 2).



a = instantaneous value of the voltage,

b = instantaneous value of the fundamental wave, and

c = amplitude of the fundamental wave.

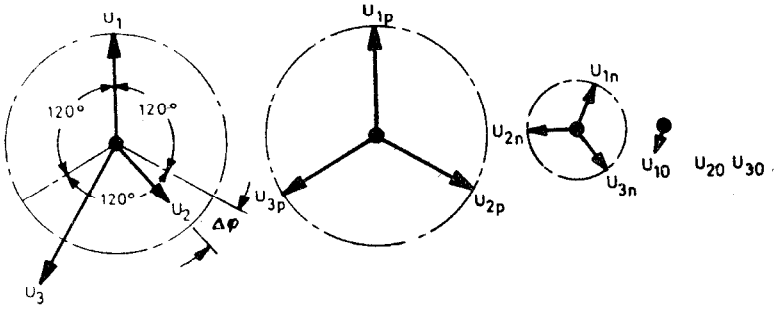
FIG. 2 VOLTAGE WAVE-FORM OF THE PRIMARY ac POWER SUPPLY

In addition to meeting the requirements of **3.2.1** the impedance of the ac system shall be considered sufficiently low if the wave-form stipulations of the preceding paragraph are met with the equipment switched off, or functioning under any normal condition.

3.4.1.2 *Symmetry of poly-phase systems* — Poly-phase supply sources shall be symmetrical in respect of the voltages.

NOTE — It shall be clearly stated in the relevant equipment specification if the equipment is specifically designed for use with a non symmetrical poly-phase system, together with its tolerances.

The voltages are to be considered as symmetrical if, with respect to the fundamental frequency, neither the negative sequence component nor the zero sequence component exceeds 1 percent of the positive sequence component, when the equipment is in operation; *see* Fig. 3.



(a) (b) (c) (d)

a) Non-symmetrical system,
b) Positive sequence system,
c) Negative sequence system, and
d) Zero sequence system.

FIG. 3 UNBALANCE OF A THREE-PHASE SYSTEM

NOTE — Any non-symmetrical three-phase system may be considered as a superposition of three symmetrical systems; a positive-sequence system a negative sequence system and a zero-sequence (in phase) system.

There is a specific relation between the components of these symmetrical systems and the amplitude and phase angle unbalance of the original non-symmetrical system.

Considering, for example the case where the negative-sequence component and the zero-sequence component both are α percent of the positive-sequence component, the largest component of the non-symmetrical system exceeds the smallest by less than 3 α percent the phase angle unbalance $\triangle \varphi$ being less than 1·72 α degrees.

These approximate values are valid when α is less than 5 percent.

If a poly-phase system is not perfectly symmetrical, but within these limits, the arithmetic mean value of all phase-to-phase voltages shall be taken as the line-to-line voltage.

3.4.2 *dc System Conditions* — Though the characteristics of dc power supply systems may also have an appreciable influence on the performance of radio transmitters connected to this type of power supply, their use is not considered to be general.

In the majority of cases, the use of a dc power supply system is restricted to certain well defined areas such as portable transmitters, transmitters for use in vehicles, shipborne emergency transmitters, radio-relay systems, etc. Within these areas, the transmitter is usually designed

to meet the prescribed requirements when connected to a specific dc power supply system that may or may not constitute a part of the transmitter itself.

The following general conditions relevant to dc power supply systems, however, may be applied in the various cases.

3.4.2.1 *Wave-form and source impedance of a supply system using dc generators* — Unless otherwise specified, a substantially smooth direct voltage source of sufficiently low impedance to have negligible influence on the operation of the radio transmitter, shall be connected to the dc terminals of the transmitter.

The direct voltage is considered to be substantially smooth if the maximum peak-to-peak value of the ripple does not exceed 2 percent of the rated operating voltage.

In addition to meeting the requirements of **3.2.1**, the impedance of the dc system shall only be considered sufficiently low if the voltage stipulations of the preceding paragraph are met with the equipment switched off, or functioning under any normal condition.

3.4.2.2 *Source impedance of a supply system using accumulators* — Unless otherwise specified, an accumulator type supply source of an impedance sufficiently low to have no influence on the operation of the radio transmitter shall be connected to the dc terminals of the transmitter.

In addition to meeting the requirements of **3.2.1**, the impedance of the supply source is considered to be sufficiently low, if, when operating at the rated supply voltage, the change in the voltage corresponding to a change from the conditions of no modulation to that of full modulation measured at the dc input terminals of the transmitter, is equal or less than 2 percent of the rated value of the supply voltage.

3.5 Environmental Conditions

3.5.1 *Standard Testing Conditions* — Measurements and mechanical tests are normally carried out at any existing combination of temperature, humidity and air pressure, provided they are within the following limits:

Temperature	+15°C	+35°C (*Note* 1)
Relative humidity	45 percent	75 percent
Air pressure	860 mbar	1 060 mbar

The temperature and relative humidity shall be substantially constant during a series of measurements carried out as a part of one test on one equipment.

For equipment incorporating transistors, measurements of temperature dependent characteristic shall also be made at 5°C and at 45°C to check the thermal stability.

NOTE 1 — The temperature range may be extended to +10°C and/or +40°C for large equipment, subject to agreement.

NOTE 2 — Where it is impracticable to carry out measurements under standard atmospheric conditions for testing, a note to this effect stating the actual conditions shall be added to the test report.

3.5.2 *Standard Reference Conditions* — If the quantities to be measured depend on temperature and/or air pressure and the law of dependence is known, the values are measured under the conditions given in **3.5.1** and if necessary, corrected by calculations to the following reference values:

Temperature	+20°C
Air pressure	1 013 mbar

NOTE — No requirements for relative humidity are given, because a correction by calculation is generally not possible.

3.5.3 *Standard Referee Conditions* — If the quantities to be measured depend on temperature, humidity and air pressure and the law of dependence is unknown, the measurements shall be made at the following conditions:

Temperature	*Relative Humidity* (percent)	*Air Pressure*
+25 ± 1°C	48-52	$8{\cdot}6 \times 10^4$Pa-$1{\cdot}06 \times 10^5$ Pa (N/m^2) (860 mbar-1 060 mbar)

Measurements at a temperature differing from 20°C are made by agreement between purchaser and manufacturer who shall also agree on suitable limits of characteristic values.

The test report shall give the actual values of temperature, relative humidity and air pressure during the measurements.

NOTE — For large equipment in test rooms, where temperature, relative humidity and/or air pressure limits as indicated above are difficult to maintain, wider tolerances are allowed, subject to mutual agreement. The actual values shall be given in the test report.

3.5.4 *Other Environmental Conditions* — When, by mutual agreement, the essential properties of a radio transmitter have to be assessed at other environmental conditions than those laid down in **3.5.1** (as for example, cold, dry heat, vibration, dust and/or sand, etc) the measurements shall be made during or after subjection to such conditions laid down in IS : 9000 (Part 1)-1977*.

*Basic environmental testing procedures for electronic and electrical items: Part 1 General.

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